**Determining the Wavelength of Light with a Diffraction Grating**

**Introduction**

In this experiment the learners will be determining the wavelength of light emitted by a laser using measurements taken from a diffraction pattern. The laser beam will pass through a diffraction grating resulting in a pattern of light on a screen at a distance from the grating. By taking simple measurements of distances with practical magnitudes in the order of cm and m they will determine a result which is of an order well below that which is directly measurable.

They are expected to be familiar with the formula *nλ* = *d* sin*θ* relating the angle of the bright spot from the central position to the wavelength.

**Aims and skills covered**

* To determine the wavelength of the laser light
* To consider uncertainty
* To consider the effect of qualitative changes

**Links to Specification**

**Physics A**

* 4.4.3(c)(d) interference, coherence and path difference, constructive and destructive interference in terms of path and phase difference
* 5.5.2(g)(h) determining the wavelength of light using transmission diffraction grating

**Physics B**

* 4.1a(v) diffraction by grating
* 4.1c(iii) path differences for diffraction grating, for constructive interference

*nλ* = *d* sin*θ*

**Practical Skills**

* 1.2.1(b) safely and correctly use a range of practical equipment and materials
* 1.2.1(c) follow written instructions
* 1.2.1(d) make and record measurements
* 1.2.1(f) present information in a scientific way
* 1.2.2(a) use appropriate analogue apparatus to record a range of measurements
* 1.2.2(j) use laser or light source to investigate characteristics of light, including interference and diffraction

**CPAC**

* (1) Follows written procedures
* (3) Safely uses a range of practical equipment and materials
* (4) Makes and records observations

**Mathematical skills**

* M0.1 recognise and make use of appropriate units in calculations
* M0.2 recognise and use expressions in decimal and standard form
* M0.6 use calculators to handle sin *x*, cos *x* and tan *x*
* M1.1 use an appropriate number of significant figures
* M1.4 make order of magnitude calculations
* M2.1 understand and use inequality symbols
* M2.2 change the subject of an equation
* M2.3 substitute numerical values into algebraic equations
* M4.5 use sin, cos and tan in physical problems
* M4.6 use of small angle approximation

**Equipment**

* laser - class 2 <1mW
* diffraction grating of known lines per mm
* stand, clamp and boss for diffraction grating
* metre rules

**Health and safety**

The CLEAPSS guidelines for use of lasers in schools should be followed:

* P52 “*Lasers, Laser Devices and LEDs (revised 2013)”*
* Laboratory Handbook section 12.12 “*Use of Lasers*”
* Student Safety Sheet 12 “*Electromagnetic Radiation*”

As stated in the above, only appropriate educational lasers should be used in the classroom.

Do not target the laser towards any learner or surface which could reflect the beam towards the class.

Ensure that the target area is a matt surface with no potential for reflection.

Do not look into the laser beam.

Before carrying out any experiment or demonstration based on this guidance, it is the responsibility of teachers to ensure that they have undertaken a risk assessment in accordance with their employer’s requirements, making use of up-to-date information and taking account of their own particular circumstances. Any local rules or restrictions issued by the employer must always be followed.

**Notes**

* These practical activities are not controlled assessments, should not be carried out in exam conditions and can be adapted by the centre. Students can collaborate during the activities which should take place as part of the normal teaching sequence. They are intended to be formative with students acquiring and practising skills throughout the course.
* To achieve a pass in the Practical Endorsement each student is required to demonstrate competence in all the skills, apparatus and techniques listed in section 1.2 of the specification and assessed against the Ofqual Common Practical Assessment Criteria (CPAC) at the end of the course.
* The skills, apparatus and techniques can be demonstrated during any practical work undertaken during the A Level course whether an OCR practical activity or not.
* This experiment may be used as one of a sequence in a circus of experiments carried out over a period of time. It is more likely to be carried out in a class context, with students setting up and taking measurements collaboratively, in which case each student should have the opportunity to take measurements to be collated for whole class use. The analysis of the data and subsequent calculations should be individual work.
* In Physics A the diffraction grating occurs in the A level specification and not the AS, although many teachers will cover this alongside the double slit experiment. Learners can complete this practical activity by using the formula given prior to covering the theory in the second year of A level, or the practical activity may be carried out at that later time.
* If computer simulation is used to allow students to work individually, it is suggested that the students are shown the actual arrangement as a demonstration in the first instance. Alternatively the simulation software can be used to reinforce the learning, or to confirm answers to the extension tasks.

Simulations are available from:

 <http://phet.colorado.edu/en/simulation/wave-interference>

 <http://www.acoustics.salford.ac.uk/feschools/waves/javaspeakers.php>

**Recording**

* Learners should not need to re-draft their work but rather keep all their notes as a continuing record of Practical Activity.
* As evidence for the Practical Endorsement learners should have the data collected in a clear and logical format. Learners should have evidence of their own readings separately from any collated class data. They should have clearly sketched the equipment and image projected.

In addition, to support the assessment of practical work in the written examinations:

* Learners should have commented on the uncertainty of each reading
* Learners should have drawn conclusions consistent with the evidence obtained
* The extension questions could be addressed with supporting justification.